IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of
Masakazu FURUKAWA et al
Serial No. 09/462,067 Group Art Unit: 3742
Filed: January 5, 2000
for : CERAMIC HEATER AND METHOD OF PRODUCING THE SAME AND ELECTRICALLY CONDUCTIVE PASTE FOR HEATING BODY

DECLARATION UNDER RULE 132

I, Yasutaka Ito, declare that:

I am an inventor of the above-referenced United States Patent Application Serial No. 09/462,067.

I received my Master of Engineering from Nagoya Institute of Technology in the year of 1990 and I have been employed by IBIDEN Co., Ltd. since 1990, wherein I have been engaging mainly in the research and development of various ceramic articles.

I have made the following examination in order to show that the present invention develops unexpected effects over Okuda et al (US 4,804,823) cited by the Examiner.

The following FIG. A shows a ceramic heater according to the present invention wherein a heating body is formed a back surface of a ceramic substrate, and the following FIG. B shows a case that a heating body is embedded in a ceramic substrate. As to a distance D between a heating body and a heating surface, if the thickness of the substrate is same, a distance Da in FIG. A becomes larger than a distance Db in FIG. B. To this end, when th h ating body is arranged on the surface of the substrate, th distanc for th rmal diffusion can

sufficiently be ensured as compared with the case of embedding the heating body in the substrate and also the temperature uniformity of the heating surface is excellent. In the heater of FIG. B, the distance between the heating body and the heating surface becomes relatively small and the thermal distribution of the heating body pattern is reflected to the heating surface as it is and hence the temperature difference of the heating surface becomes large.

In the heater of FIG. A, the distance between the heating surface and the heating body can be made large and the substrate itself is made of a high thermal conductive ceramic to provide a plate having a high thermal diffusion, so that the thermal diffusion is sufficiently performed to effectively ensure the temperature uniformity of the heating surface.

If it is intended to ensure the sufficient distance for the thermal diffusion in the heater of FIG. B, it is required to make the thickness of the substrate as shown in the following FIG. C, and as a result, thermal energy of a shadowed region becomes extra and the followability to temperature control is degraded because heat from the heating body is consumed for raising the temperature of such a shadowed region. This is clear from the comparison between Example 1 (corresponding to FIG. A) and Example 4 (substantially corresponding to FIG. B) of the specification of the present invention because the response time is 0.5 second in Example 1 and 1 second in Example 4.

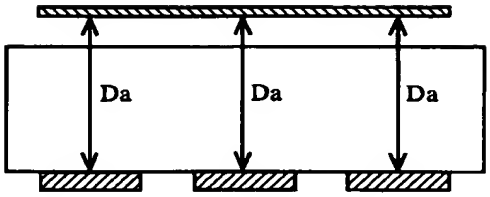


FIG.A

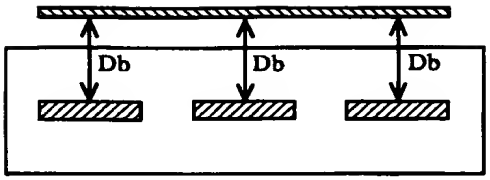


FIG.B

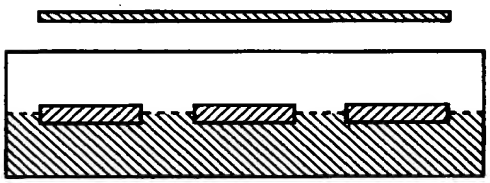


FIG.C

In the heater of FIG. A, the surface temperature difference of the heating surface is 0.5°C as seen from the attached Photograph I through a thermo-viewer, and also the temperature responsibility up to the temperature rise by the application of voltage is fast (0.5 second in Example 1, 1 second in Example 4).

On the other hand, the attached Photograph II shows a temperature distribution of a heating surface in a heater using alumina having the same thermal conductivity as quartz (0.8 W/m. K). In this case, the thermal conductivity is poor as compared with the heater according to the present invention, so that a higher temperature region is observed along the pattern of the heating body.

The attached Graph shows results measured on a transition characteristic of the heater according to the present invention until a temperature of a heating surface is r turned to an original valu of 140°C aft r a waf r of 25°C provid d with a th rmocouple is plac d on th heating surfac of 140°C. From this graph, it is clear that th

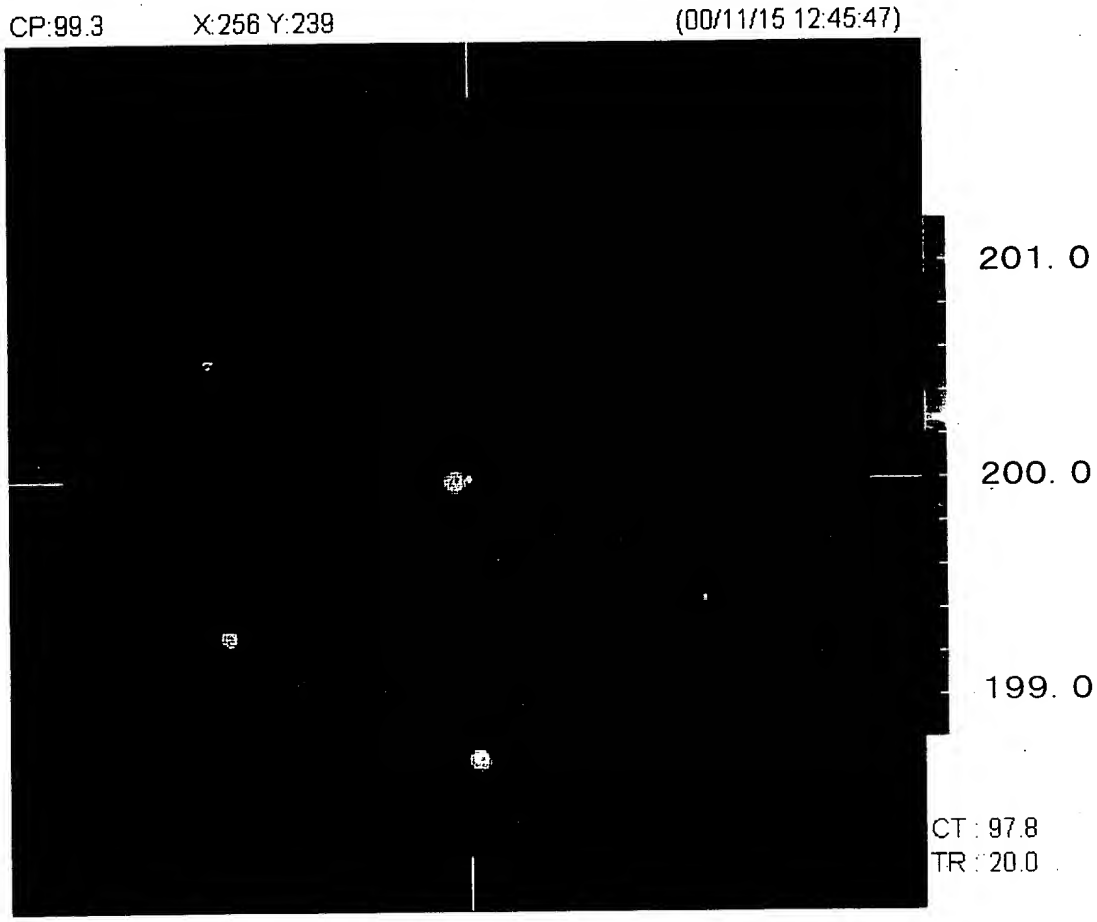
t mp rature returning tim is as v ry fast as 20 seconds. Such an ff ct of a high t mp ratur controllability is attained owing to the fact that there is substantially no time lag from the application of the voltage up to the temperature rise, which is not obtained in Okuda et al.

As the temperature rapidly rises, heat is concentrically propagated in principle, so that if the heater is quadrangle, the temperature drops down at a corner part of an outer periphery as seen from the attached Photograph III. On the contrary, in the heater according to the present invention, the substrate is disc-shape, so that there is not caused ununiform temperature as mentioned above.

As seen from the above, according to the present invention, the improvement of temperature followability (rapid temperature rise) and the temperature uniformity of the heating surface can simultaneously be realized by satisfying all of "disc-shaped ceramic substrate of nitride or carbide", "formation of heating body on a surface of the substrate" and "heating surface opposite to the surface forming the heating body". This is not taught or suggested from Okuda et al at all.

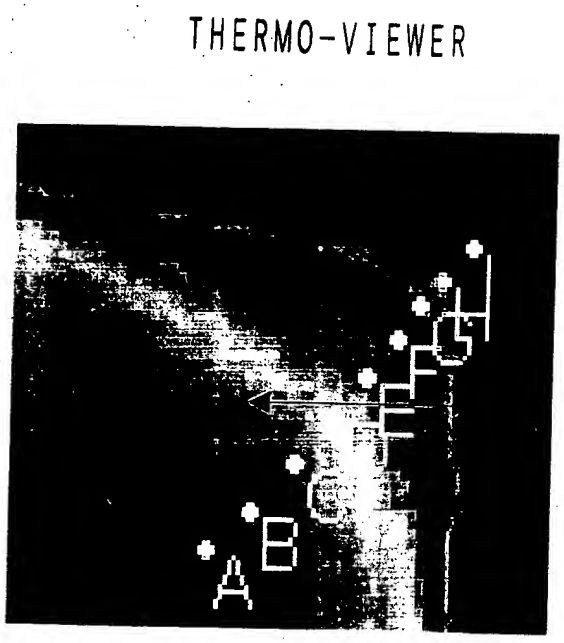
Photograph I

Thermo-Viewer (P-1)



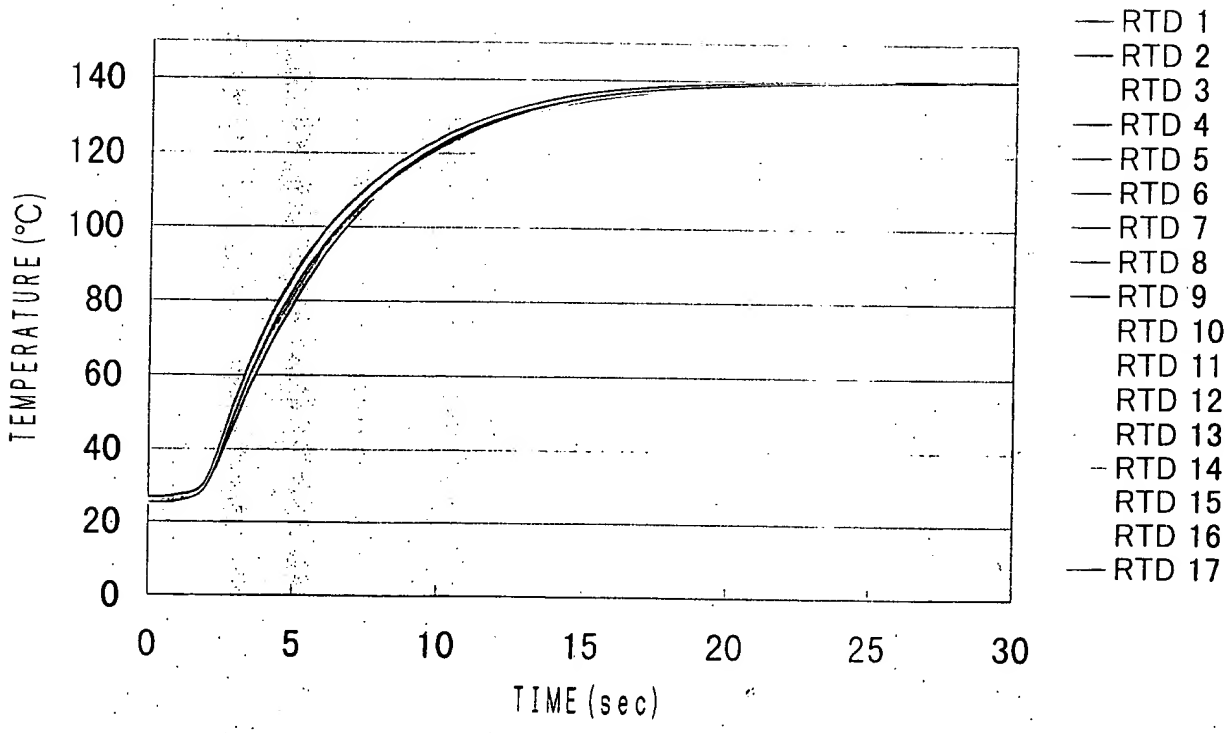
Photograph III

Thermo-Viewer (P-3)



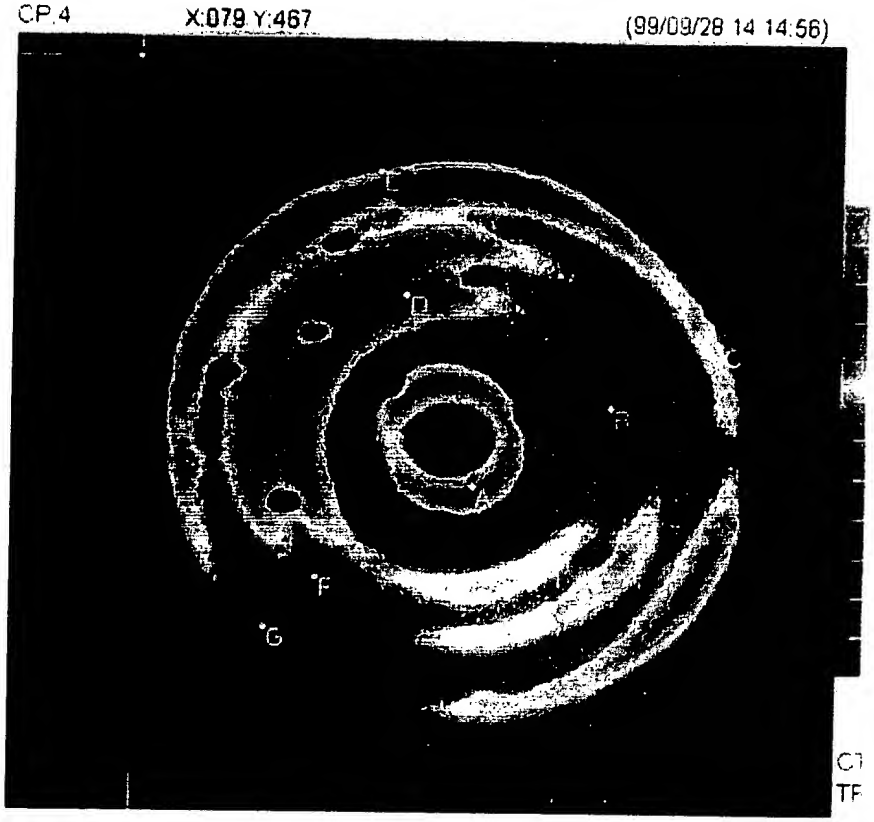
Graph

Fig.(c)



Photograph II

Thermo-Viewer (P-2)



I d clar furth r that all statem nts mad her in of my own knowl dge ar tru and that all statem nts made on information and belief are believed to be true; and further that these statements were made with knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under § 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: Sep. 10. 2001 Declarant: Yasutaka Ito

Yasutaka Ito